Biotechnology Research and Policy Activities of ABSP In Egypt

1991--2002

ABSP

The Agricultural Biotechnology Support Project

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Maize transformation for development of stem borer resistance in tropical maize.

Pioneer Hi-Bred, USA
Agricultural and Genetic Engineering Research Institute (AGERI), Egypt

1996-2001

Project Goals

Maize stem borers (*Sesamia cretica, Ostrinia nubilalis, Chilo agamemnon)* are serious insect pests in much of the maize growing area of Egypt and the Middle East and are responsible for significant loss of yield. Application of chemical pesticides has been the only contact measure taken against these insects. The overall goal of the project is to introduce into Egyptian commercial corn varieties Bt gene(s) that are known to code for proteins that are lethal to these lepidopteran species. The specific objectives of the project are as follows:

i. Transfer technologies from U.S. counterpart to establish a system(s) for regeneration and transformation of Egyptian maize lines.

ii. Production of genetically engineered maize elite resistant to stem borers specifically *Sesamia cretica* (pink corn borer), via transformation with an insect resistance endotoxin Bt gene.

iii. Develop laboratory rearing for the lepidopteran pink borer, *Sesamia cretica*.

iv. Establish methods for laboratory bioassays and field-testing.

Project Impacts

This research collaboration between Pioneer Hi-Bred and AGERI has progressed significantly. Important accomplishments include the development of regeneration and transformation systems for elite Egyptian maize lines, coupled with training of four Egyptians in molecular biology, cell culture and transformation and exposure to intellectual property and regulatory issues. An effective system was developed for the regeneration and transformation of Egyptian maize lines, a laboratory rearing facility was successfully developed, and methods were established for bioassays and field-testing.

Four novel constitutive maize promoters were isolated and Pioneer Hi-Bred filed a U.S. patent application with one Egyptian researcher as a co-inventor. The Provisional Patent Application, *Novel Maize Promoters*, was filed with a priority date of October 6, 1998 and a patent was also filed with the European Patent Office. AGERI will have certain rights to the exploitation of these promoters. This collaboration demonstrates how, through negotiation and collaboration, developing country scientists and institutions can develop and access proprietary innovations.

Through connections made during the project, Pioneer was encouraged to move some insect-resistant maize to test in the Pioneer Hi-Bred breeding program in Egypt. This was a positive impact for Pioneer and for the Egyptian community, since that represented the first such testing of such transgenic maize in Egypt).

A strong factor in the success of this project has been that a research agreement was negotiated in the initial stages of project planning that determined ownership and sharing of the IP developed during the project.

Cloning and characterization of insecticidal genes from *Bacillus thuringiensis*.

University of Wyoming, USA
University of Texas at Dallas, USA
AGERI, Egypt

1995-2001

Project Goals

There is increasing concern by scientists, agriculturists and environmentalists about the potential of insects developing resistance to *Bacillus thuringiensis* (Bt) because of its widespread use as an insecticide and in transgenic plants. Bt has been the basis of a variety of biopesticide formulations that have been produced commercially during the past 20-30 years. These biopesticides have been used extensively in the United States and in a number of other countries throughout the world. Transgenic plants carrying the toxin genes of Bt have been introduced into the United States and efforts are underway to utilize such plants in Egypt and the Middle East. Several Bt biopesticides have been marketed and used in Egypt and the Middle East for crop protection. One insect, the cotton leafworm (*Spodoptera littoralis*) which is a major problem in horticultural crops such as tomatoes, potatoes, and cucurbits as well as in corn, is effectively controlled by Bt insecticidal toxins. Recently, however, the cotton leafworm has exhibited some resistance to Bt toxins. Therefore, it is important to gain a better understanding of the molecular properties of the receptors that bind Bt toxins and that mediate toxicity to insects such as the cotton leafworm. The overall goal of this project is to investigate the molecular basis of insect resistance to the Bt toxins.

Project Activities

Cry toxin degradation by proteolysis has been postulated as a possible mechanism for insects to evade deleterious effects of Cry toxin, and therefore protease activity profiles were examined as well as toxin-binding in a strain of Colorado potato beetle resistant to the Cry3A toxin of *B. thuringiensis subsp. tenebrionis*. Specific proteolytic enzymes were found to be present in midgut extracts and brush border membrane vesicles of the resistant strain that were absent in the susceptible strain. Aminopeptidase activity associated with the vesicles from insect midgut was higher in the resistant strain than in the susceptible one. Enzymatic processing or degradation of Cry3A toxin did not differ in these strains and, apparently, is not a factor. However, the vesicles from the resistant strain bound approximately 60% less Cry toxin than vesicles from the susceptible strain. Also, saturation kinetics of toxin binding in the susceptible strain is 30-fold greater than in the resistant one. In vivo experiments confirm that the susceptible strain retains more toxin in its midgut than does the resistant strain which excretes more toxin than does the susceptible strain. Histological examination revealed that midgut epithelial cells from the susceptible insect are devastated by Bt toxin action whereas cells from the resistant insect retain their structural and functional integrity. Resistance to Bt toxin therefore involves not only decreased toxin binding and increased excretion of toxin but also changes in the composition and activity of midgut proteolytic enzymes, especially elevated aminopeptidase activity.

Potato transformation for development of tuber moth resistance

Michigan State University, USA
Agricultural Genetic Engineering and Research Institute (AGERI), Egypt
Central Research Institute for Food Crops (CRIFC, Indonesia
Vegetable and Ornamental Plant Institute (VOPI), South Africa
International Potato Center (CIP), Peru

1995-2001

Project Goal

Potato (*Solanum tuberosum* L.) is an important vegetable crop in Egypt. The area of potato under production has reached 292,000 hectare/year over three seasons (i.e. winter, spring, and summer). The total production is around 2.5 million tons annually with the winter season crop used mainly for export. Egypt exports 250,000 tons to Europe and the Arab countries. The yield is affected by infestation with potato tuber moth (PTM) *Phthorimaea operculella* (Zeller). The insect attacks potato plants in two ways: i) by mining the foliage and ii) by feeding on tubers. Therefore, it is an important pest both in field and storage and is currently controlled by large quantities of insecticides applied to the stored tubers. The overall objective of the project is to develop transgenic potatoes with resistance to potato tuber moth.

Project Activities

Researchers at MSU and AGERI have concluded the fourth year of field tests of transgenic potatoes with resistance to Potato Tuber Moth (PTM). The researchers have 2 years worth of data on the resistance of transgenic *Spunta* potatoes, a local fresh market cultivar in Egypt. These *Spunta* lines, transformed with a *cryV* Bt gene, show strong control of PTM in the tuber (99-100%). Phenotypically, they are similar to untransformed *Spunta*, and should be acceptable to Egyptian consumers and growers. Two years of storage trials have demonstrated that resistance to PTM holds for approximately 2-3 months under ambient storage (using the traditional Nawalla storage system in Egypt) and the results appear long lasting (over a year) in cold storage. MSU researchers currently have additional lines that will be field-tested in early 2001 that will target the Egyptian chip processing industry. A detailed plan is currently being developed for commercialization of Bt potatoes in Egypt that will include environmental data to be collected and analyzed, food safety data to be developed and intellectual property issues to be addressed.

The field tests in Egypt are the most advanced of any trials in the developing world sponsored by the public sector. Future efforts will focus on registration of the materials and developing a resistance management strategy and food safety assessments for the materials in order to commercialize the product. The expertise required for this effort, as well as the costs incurred, are currently being determined. While the research achievements of this project are considerable and are a model for international collaboration in biotechnology, the full impact of this effort will hinge on the difficulty and expense of bringing the transformed lines to the farmers and public. It is unclear how Egypt will develop its commercialization procedures for transgenic potatoes, but if it adopts a stringent European model, it will be difficult for a public-funded effort to meet the regulatory costs.

Project Impacts

The development of effective gene constructs for potato transformation with Bt genes for resistance to potato tuber moth.

Development of transgenic potatoes with resistance to PTM. Of particular interest are the newly developed potato lines, Spunta G2 and Spunta G3. These are from a locally grown Egyptian variety transformed with a Cry V vector without the GUS reporter gene and show very high levels of resistance to potato tuber moth. The Spunta variety is locally used and not exported to the EU. It also looks different from the common export varieties, easing any concerns about export problems.

Multiple years of field-testing of transgenic potatoes in a developing country. Several years of field tests in Egypt and two years of tests with resistant and susceptible tubers in traditional Egyptian storages have been completed. All studies show nearly 100% control of tuber moth, even when the parent Spunta line is heavily infested (up to 100% in storage trials).

Effective linkages to international centers and to other developing country institutions to expand evaluation of material and to analyze potential impact.

This has been a very effective project for many reasons. The research team grouping of a plant breeder, a molecular biologist, and an entomologist has been very helpful in taking the research from lab to field.

There has been a high level of flexibility within the project allowing the researchers to bring other groups and individuals on board as new issues have arisen, e.g. food safety consultancy, and an audit of intellectual property issues.

Difficulties in the commercialization of these varieties are however anticipated in the regulatory process because the public sector does not have the expertise or the resources to develop such regulatory packages.

Current transformations are underway using public domain genes that are not under patent, to improve the probability of commercialization.

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Development of potyvirus resistant cucurbits

Michigan State University, USA
Cornell University, USA
AGERI, Egypt
Asgrow, USA

1995-2001

Project Goal

Cucurbit species include a variety of high value crops (e.g., melons, watermelon, cucumber, summer squashes, winter squashes) that play important roles in both local diets and as export crops throughout the world. The area under cultivation with squash crop in Egypt is around 78,000 feddans and produces about 568,000 tons. In addition, the export values for melon and watermelon exceed $1 million annually. Currently a major limitation of successful production of these crops is infection by several viruses including the potyviruses, zucchini yellow mosaic virus (ZYMV), watermelon mosaic virus (WMV), the watermelon strain of papaya ringspot virus (PRSV-W), and the cucumovirus, cucumber mosaic virus (CMV). Crop losses of 50-100% in individual locations have been reported frequently. The control of such viruses based on using insecticides and/or inspection and rouging is usually ineffective. The overall goal of this project is to develop high quality cucurbits with multiple virus and disease resistances using a combination of molecular genetic and conventional breeding approaches.

Project Impacts

Cornell University

A wide array of breeding lines have been developed in 4 cucurbit species widely adapted for tropical and temperate environments with multiple disease resistance.

In *Cucurbita pepo*, the Eskandarany type favored in the Middle East, caserta, green, grey and black zucchini have been developed with resistance to one or more of the following four viruses, zucchini yellow mosaic virus, watermelon mosaic virus, papaya ringspot virus and cucumber mosaic virus. In all cases, virus resistance has been combined with resistance to a ubiquitous fungal disease, powdery mildew, and in some cases lines have also been bred with reduced attractiveness to cucumber beetles, an important pest, and also vector of bacterial wilt. These lines have been trialed all over the world including Egypt, Jordan, South Africa, the Philippines, Indonesia, and Brazil (see below).

In *Cucurbita moschata*, the tropical pumpkin, virus resistance has been crossed into tropical types and the plants trialed in the Philippines. Butternut types have been bred with multivirus resistance and resistance to powdery mildew and trialed successfully in South Africa. An open-pollinated variety, Bugle, has been licensed to Seminis for use in South Africa.

In *Cucumis melo*, resistance has been bred to CMV, PRV, ZYMV and WMV + powdery mildew in sweet orange flesh netted shipper types and sweet crisp green and white flesh melons that combine well as a parent for widespread use in commercial hybrids. Work has also begun to introduce multivirus resistance and powdery mildew resistance to two additional types of tropical melons, Ananas and Galia. With additional support from the American Seed Trade Association, genes have also been identified for high levels of resistance to a fungal disease called Gummy Stem Blight, widespread in the tropics and in humid temperate production areas. Breeding lines have been created with 3 or more of these genes combined to create much higher levels of resistance than observed when the genes are present alone.

In cucumber, breeding lines have been created in the Beit Alpha (smooth, uniform dark green, glossy, fine spine) and Asian (smooth, very slender and long, uniform dark green, glossy and parthenocarpic) types with various combinations of resistance to the following diseases and pests: four viruses, three leafspots, scab, reduced attractiveness to cucumber beetles, powdery and downy mildew. These breeding lines have been trialed in Egypt, the Philippines, Indonesia, S. Africa, and Brazil.

This material has also proven useful in the N. American market and in recognition of the importance of these resistances and the product quality of our breeding lines, Jahn and Moriarty were awarded the 2002 Gold Medal for a *C. pepo* variety in the All America Selections/National Garden Bureau competition.

A major field day was hosted in Ithaca in 2000 and attended by 15 seed companies from around the world, and seed from the program has been sent to Africa, Asia and Latin America for trials.

Simple one page material transfer agreements and two page commercial licenses have been developed and accepted by a broad range of companies in the developed and developing world.

Private sector cooperators have been identified and are now conducting major trials of ABSP germplasm in South Africa, Indonesia, and Brazil. Trials of this material have also been or are currently being conducted in Jordan and the Philippines.

A number of U.S. and European seed companies are also actively breeding with the above material in various locations around the world including Latin America, Mexico, France, the Netherlands, Turkey and India. Syngenta is conducting the most extensive of these trials in early 2001 in Jordan.

Material has also been distributed to a consortium of 27 seed companies from N. America, Europe, Asia, Africa, Australia and New Zealand that are part of the Cornell Vegetable Breeding Institute.

Michigan State University

During the past several years various groups have shown that it is possible to genetically engineer resistance to these viruses in cucurbit crops, but a major limitation to more widespread application of this technology to various cucurbit crops is the lack of efficient transformation systems. For some species there are no available transformation systems, and for others the transformation systems can be very inefficient and/or highly genotype specific. In the past few years, new, non-regeneration dependent methods of plant transformation have been developed for a small number of species. The primary motivating factors to develop such methods have been to bypass difficult and low efficiency regeneration protocols.

A major objective of this work at MSU is to develop a novel, non-regeneration based system for cucurbit transformation. To this end two approaches are being investigated: one is an electrotransformation system recently developed for use with legume crops. If successful, this methodology would have value for any future traits to be incorporated; would have the added benefit of being broadly applicable across genotypes and even species, should be readily replicated in other laboratories, and would avoid the time, effort, expense and sophistication necessary for regeneration based systems. The second approach involves adaptation of a pollen-tube transformation method that has been widely used in China for several species including wheat, cotton, soybean, rice, and recently watermelon. If successful, this method would be even simpler, and involve less sophisticated equipment than electrotransformation.

Results have suggested that the electrotransformation procedure is successful when the DNA is directly incorporated into the developing floral. Treatment protocols have therefore been revised to treat older seedlings at a time when they are in the process of initiating floral primordia. Fruit has been collected from approximately 200 treated plants and their seeds are now being screened. Pollen tube-mediated transformation has also been tried and seedlings produced from fruit of plants treated in this way are now being screened. The *Agrobacterium*-mediated transformation system has been used to successfully transform the American cucumber genotypes, Straight 8 and GY14. At least five gene constructs have been successfully introduced as verified by PCR analysis. The Indonesian cultivar Hijau Roket did not regenerate well in the Agrobacterium system. An MSU

international graduate student from Egypt has been instrumental in establishing the *Agrobacterium*-mediated cucumber transformation system and is currently engaged in introducing *Arabidopsis* cold-responsive transcriptional factor genes to confer resistance to cold, drought or salt.

Egypt

AGERI researchers, using a construct with the ZYMV coat protein gene developed by MSU, transformed squash plants (using a local Egyptian cultivar, Escandarani) and evaluated resistance under greenhouse and field conditions at AGERI. Preliminary field trials in 1999 and 2000 demonstrated that a majority of transformed plants appeared highly resistant (92-96%) to ZYMV infection, with symptoms of virus infection not appearing until eight weeks post-inoculation.

Melons have also been transformed to resist ZYMV and these plants have been tested in the greenhouse. AGERI researchers developed a transformation and regeneration system for Shahd EL-Dokki, a local Egyptian cultivar. Two lines were tested through the R_2 generation and a number of plants appeared to be free of virus symptoms at six weeks post inoculation with ZYMV.

AGERI researchers have introduced the ZYMV coat protein gene into cucumber plants using a local cultivar Beit Alpha via *Agrobacterium tumefaciens* transformation. Four lines contain the ZYMV coat protein gene via ELISA and PCR analysis and await further characterization.

AGERI researchers have also established a regeneration system in watermelon using the Egyptian cultivars Giza1 and Giza2. This work is still in progress.

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Production of tomato yellow leaf curl virus (TYLCV) resistant tomato

ILTAB, Scripps Research Institute, USA
AGERI, Egypt

1995-1998

Project Goals

Tomato yellow leaf curl disease is a very devastating disease, throughout Africa, the Middle East and South-East Asia. The severity of the disease is dependent on the epidemiology and distribution of the whitefly vector, and as whiteflies are invading new ecological territories, TYLCV is becoming a threat in new areas. Losses to the disease can be extensive and may reach 100% in some areas. In Egypt, of the total production area of 484,963 ha, the losses have been estimated in the range of 5 to 35% from season to season. Current control measures are only partly effective and insecticide treatments are unable to control the vector. The specific objectives of the project are:

1. To establish a collaborative research project with Egyptian counterparts at AGERI, Cairo, Egypt, for exchange of information, reagents, and technology relative to the diagnosis and control of geminivirus diseases in tomato for Egypt.
2. To develop strategies and reagents for the diagnosis of such viruses for use in Egypt and other relevant regions of the world.
3. To develop strategies via plant genetic transformation to develop plants that are resistant to tomato yellow leaf curl virus (TYLCV) a major disease of tomatoes in Egypt.

Project Impacts

Several clones of TYLCV-Eg were obtained and sequenced by AGERI scientists.

Oligonucleotide PCR primers were developed that can be used to identify whitefly-transmitted geminiviruses. The primers have been tested at ILTAB and at AGERI, and have been distributed to other researchers around the world for field diagnosis of whitefly-transmitted geminiviruses.

A large number of chimeric genes were constructed using sequences derived from the genome of TYLCV-Eg.

Polyclonal antibodies were produced against the coat protein, the pre-coat, and the replicase of TYLCV-Eg. The antibodies for the coat protein are also capable of detecting any whitefly-transmitted geminivirus.

Tomato transformation has been firmly established with both marker genes and genes derived from the genome of the Egyptian strain of TYLCV. More than 240 transgenic lines were developed. The protocol adopted has led to frequencies of transformation approaching 9% in selected experiments. Transfer of the successful protocol to AGERI has been achieved and tomato transformation can be carried out in Egypt.

AGERI researchers have identified two different kinds of whitefly-transmitted geminiviruses (tomato yellow leaf curl virus [TYLCV] and tomato yellow mosaic virus [TYMV]) that infect tomatoes in Egypt.

The genome of Egyptian isolate of TYLCV has been cloned, sequenced and compared with other geminiviruses.

An infectious TYLCV clone was established and transformed into tomato cultivars that, at the greenhouse level, appear to be resistant to TYLCV infection. The transformed tomatoes carry a cytotoxic gene that is not expressed unless the cell is infected by a whitefly-transmitted geminivirus. While still preliminary, these early results are among the first demonstrating control of geminivirus.

Using the training received in the U.S. and constructs from U.S. collaborators, AGERI has, to our knowledge, developed the first transgenic tomatoes (and cucurbits – see previous section) within USAID-assisted countries produced by developing country scientists. A number of lines have been field tested at AGERI, and AGERI is currently in active discussions with local industry in how to adapt these materials and/or techniques for the benefit of private sector horticultural interests in Egypt and the Middle East.

Publications

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Whitefly biotypes and biotype-specific transmission of geminiviruses

University of Arizona
AGERI, Egypt

1995-1998

Project Goals

Whitefly-transmitted geminiviruses are among the most important emerging viral pathogens in arid, irrigated monoculture systems, worldwide. Geminiviruses have emerged as global pathogens due to recent upsurges in populations of *Bemisia tabaci,* the only known vector of this group of geminiviruses. Little is known about the identity and distribution of geminiviruses infecting vegetable crops in Egypt, and there is no information concerning geminivirus-whitefly vector interactions except one study conducted at AGERI under this project. Populations or biotypes of the most important geminivirus vector, *Bemisia tabaci* (Genn.), are morphologically indistinguishable, yet they have adapted to distinct niches in native and cultivated plant communities and are highly variable in terms of their actual threat to crops.

Different populations of *B. tabaci* vary with respect to biological attributes such as host preferences, virus vector capacities, and levels of insecticide resistance. Accurate biotyping of whiteflies is therefore important for implementing effective crop management strategies to control virus diseases transmitted by whiteflies and the damage inflicted by whitefly feeding. Specific objectives of this project were as follows:

To identify the distinct whitefly vector populations in tomato and vegetables using protein polymorphism and molecular markers.

To define population-specific transmission profiles between predominant whitefly biotypes and TYLCV in tomato, and other geminiviruses of vegetable crops.

In order to achieve these goals the specific research objectives were as follows:

1. To identify primers that will differentiate between Egyptian populations of *Bemisia tabaci,* the vector of tomato yellow leaf curl, collected from isolated geographic locales in crop and weed hosts of the whitefly,
2. To investigate the degree of relatedness between Egyptian whitefly vector populations and those in the adjacent regions,
3. To corroborate biological (host preferences, vector relations), biochemical, and molecular data sets for populations studied in the AZ and AGERI laboratories.

Project Impacts

Documentation of the distribution of distinct whitefly vector populations in Egypt using biochemical and molecular markers in collaboration with AGERI scientists.

Initiation of tracking of distinct vector populations and geminiviruses associated with vegetable crops, particularly tomato, throughout Egypt and within the region.

Establishment of whitefly vector colonies at AGERI and whitefly-transmission experiments with tomato yellow leaf curl virus using two whitefly species, *B. tabaci* and *T. ricini*. Substantial work was conducted with *T. ricini*.

The AZ group developed the core Cp primers for the detection of geminivirus coat protein gene fragment in single whitefly vectors and in plant samples.

PCR primers from AZ and AGERI laboratories are now available to detect geminiviruses in individual whiteflies and infected plants.

Developing drought and salinity tolerant wheat and tomato for Egyptian agriculture

Ohio State University, USA
AGERI, Egypt

1998-2001

Project Goal

Water stress (hyperosmotic) caused by drought and salinity is the most important abiotic factor limiting plant growth and crop productivity worldwide (Boyer, 1982). Arable land acreage is limited in Egypt due to the lack of water needed for irrigation. Agricultural development in many areas of the country will depend mainly on irrigation with mixed fresh and drainage water, which raises the need for developing crop cultivars with increased salt and drought tolerance. The gap between future supply and demand in wheat and tomato (strategic commodities in the Middle East) makes it imperative to increase cultivation in the areas where sub optimal conditions, such as water deficit, salinity, and high temperature, prevail.

The overall goal of this project is to enhance osmotic stress tolerance in Egyptian wheat and tomato crops. This will be achieved by over expressing the key regulatory enzymes of the proline biosynthesis and sulfur assimilation pathways. Research will investigate whether elevated levels of proline and active sulfur confer drought and salinity tolerance in two plant systems, i.e., wheat and tomato, and attempts will be made to find gene(s) able to convert proline into proline betaine.

Project Progress

AGERI scientists have established a transformation and regeneration system for wheat and transformed a number of genes that have been reported to affect drought and salt tolerance. The *mtlD* gene (from *E. coli* and which accumulates mannitol), the HVA1 gene (from barley and which confers delayed leaf wilting), and the fructan gene (from *Bacillus subtilis* and which plays a role in osmotic adjustment to changing environmental conditions) were all transformed into wheat. Early results indicate that the transformed lines are expressing the genes and proteins and, under laboratory conditions, appear to be more salt tolerant than controls. Confirmation of these results await greenhouse and field tests.

Egypt Biosafety

Activities

➤➤ **Biosafety Internship Program: Guidelines Development, MSU, May-July 1993.**
ABSP organized an eight week internship program in the US with the goal of assisting collaborating countries in the development of biosafety guidelines that would allow them to exchange and test biotechnology products. Seven scientists from Egypt, Kenya and Indonesia participated in the ABSP Biosafety Intern Program, May-June 1993. The Indonesian scientists then participated in a *hands-on* biosafety training program at ICI Seeds, Iowa, while the Egyptian and Kenyan Scientists participated in a program at Michigan State University. The scientists then reconvened in Washington DC where they had the opportunity to interact with federal personnel at USDA/APHIS, FDA and EPA responsible for various aspects of biosafety.

➤➤ **Genetic Resources Workshop, Egypt, June 1994.**
The ABSP/AGERI project, in cooperation with Genetic Resources Communication Systems (GRCS), Inc., the Egyptian National Research Program, and USAID/Cairo held a two day Genetic Resources Workshop in Cairo. The workshop brought together experts from Egypt and from the international Community to discuss various issues related to genetic resources in Egypt and the region. A special Issue of *Diversity* journal focusing on this workshop was published. The Mediterranean issue of *Diversity* was translated into Arabic and 3,000 copies of this version were distributed.

➤➤ **Biosafety Workshop at AGERI, Egypt, January 1994.**
The goal of this workshop was to create a greater awareness and strengthen the biosafety regulatory framework in Egypt and the Middle East. The workshop involved international experts on in biosafety, and scientists and regulatory personnel from Egypt and selected countries in Africa. The workshop addressed policy, risk assessment and field-testing issues surrounding the management and safe handling of transgenic plants. The proceedings were published [*Biosafety/Intellectual Property Rights Project Evaluation, Proceedings from the AGERI & ABSP Workshop Series January 24 - 31, 1994, Cairo, Egypt.]*

➤➤ **Consultations on Egyptian Biosafety Guidelines, 1994.**
Dr Patricia Traynor reviewed the Egyptian draft biosafety guidelines and provided comments.

➤➤ **Construction of Containment Greenhouse Facility at AGERI, Egypt, 1995.**
ABSP provided leadership in the development of a cooperative sub agreement to the AGERI/ABSP collaboration with the University of Arizona for the construction of a BLP-2 containment greenhouse facility at AGERI. Certification of the containment facility was authorized by the Chief of Microorganisms Branch at the USDA/APHIS/BBEP who stated in his report that "the biocontainment greenhouse facility at AGERI meets the international standards for growing genetically engineered organisms, and is ready for commission."

Impacts

➤➤ **Biosafety Guidelines Developed and Approved**
Egypt is among the developing countries most advanced in the adoption and use of agricultural biotechnology. AGERI's mandate – to develop transgenic products tailored for local conditions and consumer preferences – clearly indicated the need for the development of a regulatory

system. Additionally, multinational companies have been seeking permission to import their GMO crops for testing in Egypt since 1995. Impacts of the ABSP have included:

- Training of the AGERI Biosafety Officer assigned with drafting biosafety guidelines for laboratory, greenhouse and field experiments
- Construction of a biocontainment greenhouse facility
- A National Biosafety System was instituted by the Ministry of Agriculture and Land Reclamation in two decrees issued in 1995. Ministerial Decree No. 85 (January 25, 1995) established a National Biosafety Committee (NBC); Ministerial Decree No. 136 (February 7, 1995) adopted biosafety regulations and guidelines for Egypt. The system involves several ministries, organizations and/or government agencies involved with the importation, exportation and local production of natural products. The guidelines describe the modalities of use, handling, transfer, and testing of transgenic organisms. They address laboratory practices, greenhouse containment, and small-scale field-testing. Procedures for commercial release were established in 1998 by Ministerial Decree No. 1648. Development of food safety laws/regulations is currently underway.
- Field-testing of GMOs, including insect-resistant potatoes (MSU and AGERI), virus resistant squash (AGERI) and virus resistant tomatoes (AGERI) and Bt resistant maize (Fine Seeds/Novartis).

Egypt IPR/Technology Transfer

Activities

➤➤ Intellectual Property/Patent Internship Program, Stanford University, April 1993.

An IPR internship program was designed and implemented by Professor John Barton of Stanford Law School from April 1-30, 1993. Seven interns from Egypt, Kenya and Indonesia participated in the program, the goal of which was to provide hands-on experience to legal and scientific personnel from developing countries in various issues related to intellectual property rights. In addition the internship enhanced communication between those involved in the sciences and those with responsibilities in the legal issues surrounding biotechnology. The program encouraged the assessment of current intellectual property structures within the participants' home countries, provided access to literature and expertise regarding IPR in both the public and private sectors.

➤➤ Workshop On Intellectual Property Rights, Patents & Licensing, Egypt January 1994.

This workshop, designed by Prof. John Barton, George E. Osborne Professor of Law at Stanford Law School, was held in Cairo, Egypt from January 24-25, 1994. Over 100 participants from various public and private sector institutions attended the workshop, the goal of which was to create a greater awareness among the Egyptian scientific community in the various issues relating to intellectual property in agricultural biotechnology. The workshop involved scientists, legal professionals and government officials from Egypt. Proceedings of this workshop were published.

➤➤ IPR Workshop, Washington DC, July 1994.

ABSP sponsored this workshop in Washington DC from July 11-14, 1994 as a follow up to the Egypt workshop. Forty-four participants attended from Egypt, Kenya, Indonesia and Costa Rica, Thailand, Sri Lanka as well as a number of institutions and agencies such as USAID and the World Bank. The purpose of the workshop was to present intellectual property rights in biotechnology as an important issue to institutions and individuals. Proceedings of this workshop were published: *Intellectual Property Rights, Proceedings from the ABSP Workshop Series July 11 - 14, 1994, Washington, D.C.*

➤➤ Intellectual Property Rights Seminar on the Legal Framework for Technology Transfer, Egypt 1995.

Under the auspices of the American Embassy in Cairo, the ABSP/AGERI project assisted in the organization of a two-day seminar on the legal framework for technology transfer. The seminar focused on intellectual property rights and technology transfer issues within the context of recent changes in GATT. Over 100 representatives from government and private sector institutions in agriculture and the pharmaceutical industry attended the workshop.

➤➤ Linkages with the Association of University Technology Managers (AUTM), 1995-2001.

In order to build intellectual property management and technology transfer capacity in collaborating countries, the ABSP project has since 1995 developed close links with the Association of University Technology Managers (AUTM) in the US. The AUTM is a professional association of technology transfer managers from academia, government institutions and industry. The ABSP Technology Transfer Coordinator has attended the annual meeting of AUTM since 1995, and ABSP has sponsored participants from Indonesia (7), Costa Rica (1), South Africa (1), Egypt (4), Morocco (5), and Kenya (2) to attend the annual or regional meetings of AUTM in the US.

➤➤ ABSP Industrial Seminar Series

In April 1993, the ABSP organized an Industrial Seminar Series (ISS). The ISS was organized to provide opportunities for senior scientists and administrators from the public and private sector, and government officials from the ABSP partner countries (Costa Rica, Egypt, Indonesia, Kenya) to interact with technical and business personnel at private biotechnology companies in the U.S. that have active agricultural biotechnology programs. In addition to seven participants from the ABSP partner countries, three participants from Jamaica (sponsored by the USAID-Jamaica) also attended the ISS. The companies visited included Garst/ICI Seeds, Inc. (now Syngenta), Ecogen Inc (now part of Monsanto), and DNA Plant Technology. The ISS was instrumental in opening lines of communication between developing country leaders and host companies. It also provided participants an exposure to a diverse group of companies oriented towards different end-user groups.

Impacts

➤➤ Establishment of the Technology Transfer Office at Agricultural Genetic Engineering Research Institute (AGERI).

The Office of Technology Transfer and Intellectual Property (OTTIP) at AGERI was established. Internal IP policy was developed and approved. A model Material Transfer Agreement (MTA), a License Agreement and a Confidential Disclosure Agreement were developed, based on MSU Office of Intellectual Property forms, in both English and Arabic and a comprehensive awareness program for AGERI staff was implemented. This effort makes AGERI one of a only few developing country institutions to adopt policies and procedures for management of intellectual property rights.

➤➤ Adoption of technology transfer policy within the Ministry of Agriculture (ARC).

In addition to developing IP policy at AGERI, the OTTIP has been instrumental in developing an IP policy for the Agricultural Research Center (equivalent to an Agricultural Research Service/USDA policy). The ARC has more than 10 research institutions covering a wide range of agricultural research, including mechanization, pesticide research and horticulture. This ARC policy makes Egypt one of the only developing countries to have developed a government strategy on the management of intellectual property rights in agriculture.

➤➤ Establishment of an Intellectual Property Rights (IPR) Center at Menoufia University.

Through IPR training provided in Cairo in April 1999 for Professor Ibrahim Siddik, Vice President for Community Services, the Menoufia University in Egypt established a new IPR Center in the Faculty of Law. This new Center provides IPR related legal services to the university community. Menoufia University has 17 colleges/institutes with approximately 2,000 faculty members and 60,000 students. The establishment of intellectual property rights services within the university community in Egypt is an important extension of ABSP's efforts to establish IP management expertise and assistance to scientists in the developing world.